

# WEI ZHANG

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## EDUCATION

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### University of Washington - Seattle, USA

June 2008 - June 2013

Ph.D. in Materials Science & Engineering

dual Ph.D in Nanotechnology from *Molecular engineering & Sciences Institute*

Thesis title: *Competing Anisotropies in Epitaxial Exchange Biased Thin Films and Patterned Nanostructures.* Advisor: Kannan M. Krishnan.

Committee: Xiaodong Xu, Peter Pauzauskie, Jiangyu Li, Marjorie Olmstead.

### Peking University, China

September 2004 - June 2008

B.S. in Physics

Thesis title: *Fabrication, characterization and magnetic properties of CoCr<sub>2</sub>O<sub>4</sub> nanoparticles.* Advisor: Chinping Chen.

## PROFESSIONAL EXPERIENCE

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### Materials Science Division, Argonne National Laboratory

June 2013 - Present

*Postdoc appointee (with Dr. Axel Hoffmann)*

*Argonne, IL*

- Novel sputtering techniques for the growth of magnetic insulator films and related heterostructures
- Design and fabrication of magnetic devices for spin pumping and spin-orbit torques
- Enable energy-efficient devices using spin Hall effects, spin Seebeck effects and Rashba-Edelstein effects
- Spin and charge transport in two-dimensional transitional metal dichalcogenides

### Materials Science and Engineering, University of Washington

June 2008 - June 2013

*Research assistant (with Prof. Kannan M Krishnan)*

*Seattle, WA*

- Constructing longitudinal and transverse scanning MOKE with angular-dependent degree of freedom
- Epitaxial growth of magnetic films and heterostructures, vacuum equipment maintenance
- Exchange bias, perpendicular magnetic anisotropy, magnetic interfaces
- Epitaxial lithographic patterning, nanoimprint lithography, contact printing
- Enable lithographic nanoparticles for biomagnetism

#### *Teaching assistant*

- General physics lab
- Materials Characterization

### SLAC National Accelerator Laboratory, Stanford University

April 2015

*On-site facility user (with Dr. Hendrik Ohldag)*

*Stanford, CA*

- Direct x-ray imaging of spin current and spin accumulations by spin pumping

### Molecular Foundry, Lawrence Berkeley National Laboratory

July 2012

*On-site facility user (with Dr. Deirdre Olynick)*

*Berkeley, CA*

- Sub-100 nm nanoimprint lithography, reactive ion etching

### Seagate Technology, LLC

June 2011 - July 2011

*Engineer intern (with the Nanoimprint group)*

*Fremont, CA*

- Patterned storage media
- Non-aggressive reclaim process for nanoimprint stamp

**Advanced Light Source, Lawrence Berkeley National Laboratory**  
*On-site facility user (with Dr. Peter Fischer)*

July 2009  
*Berkeley, CA*

- X-ray magnetic domain imaging

**Low Temperature Lab, Peking University**  
*undergraduate researcher (with Prof. Chinping Chen)*

September 2006 - May 2008  
*Beijing, China*

- Chemical synthesis and characterization of magnetic nanostructures

## TECHNICAL STRENGTHS

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Systematic trainings on the fabrication and characterization of electronic and magnetic nanodevices. Proficient in ion beam sputtering, magnetron sputtering, nanoimprint lithography, e-beam lithography, photolithography, etching, probe station, profilometer, x-ray diffraction, scanning probe, scanning electron microscopy, vibrating sample magnetometer, magneto-optic Kerr effect, PPMS, MPMS, Labview.

## PUBLICATIONS

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### Submitted or accepted:

- **W. Zhang** and K. M. Krishnan,  
 ‘Epitaxial exchange-bias systems: from fundamentals to future spin-orbitronics’, (invited review)  
[submitted](#)
- **W. Zhang**, J. Sklenar, B. Hsu, W. Jiang, M. B. Jungfleisch, K. Tarkar, F. Y. Fradin, Y. Liu, J. E. Pearson, J. B. Ketterson, Z. Yang, and A. Hoffmann,  
 ‘Current induced spin torque resonance in Permalloy on a monolayer MoS<sub>2</sub> at room temperature’,  
[submitted](#)
- **W. Zhang**, J. Ding, S. Li, J. E. Pearson, V. Novosad, and A. Hoffmann,  
 ‘Epitaxial patterning of nanometer-thick Y<sub>3</sub>Fe<sub>5</sub>O<sub>12</sub> films with low magnetic damping’,  
[submitted](#)
- J. Sklenar, **W. Zhang**, M. B. Jungfleisch, W. Jiang, H. Chang, J. E. Pearson, M. Wu, J. B. Ketterson, and A. Hoffmann,  
 ‘Driving and detecting ferromagnetic resonance in insulators with the spin Hall effect’,  
[accepted by Phys. Rev. B, ArXiv:1505.07791](#)
- M. B. Jungfleisch, **W. Zhang**, W. Jiang, and A. Hoffmann,  
 ‘New pathways towards efficient metallic spin Hall spintronics’, (invited review)  
[accepted by SPIN](#)
- S. M. Wu, **W. Zhang**, A. KC, P. Borisov, J. E. Pearson, J. S. Jiang, D. Lederman, A. Hoffmann, A. Bhattacharya,  
 ‘Antiferromagnetic spin Seebeck Effect’,  
[submitted, ArXiv:1509.00439](#)
- M. B. Jungfleisch, **W. Zhang**, J. Sklenar, J. Ding, W. Jiang, H. Chang, F. Y. Fradin, J. E. Pearson, J. B. Ketterson, V. Novosad, M. Wu, A. Hoffmann,  
 ‘Large spin-wave bullet in a ferrimagnetic insulator driven by spin Hall effect’,  
[submitted, ArXiv:1508.01427](#)
- M. B. Jungfleisch, **W. Zhang**, J. Sklenar, W. Jiang, J. E. Pearson, J. B. Ketterson, A. Hoffmann,  
 ‘Interface-driven spin-torque ferromagnetic resonance by Rashba coupling at the interface between non-magnetic materials’,  
[submitted, ArXiv:1508.01410](#)

- P. Li, T. Liu, H. Chang, **W. Zhang**, Wei Li, D. Richardson, A. Demann, G. Rimal, H. Dey, J. S. Jiang, G. Csaba, W. Porod, S. Field, J. Tang, M. C. Marconi, A. Hoffmann, and M. Wu, , ‘Spin Transfer Torque-Assisted Switching in Magnetic Insulator Thin Films with Strong Perpendicular Magnetic Anisotropy’, submitted

### Published:

- 29. *Review article*: **W. Zhang** and K. M. Krishnan, ‘Epitaxial patterning of thin-films: conventional lithographies and beyond’, *J. Micromech. Microeng.* **24**, 093001 (2014).
- 28. **W. Zhang**, M. B. Jungfleisch, F. Freimuth, W. Jiang, J. Sklenar, J. E. Pearson, J. B. Ketterson, Y. Mokrousov, and A. Hoffmann, ‘All electrical manipulation of magnetization dynamics in a ferromagnet by antiferromagnets with anisotropic spin Hall effects’, *Phys. Rev. B* **92**, 144405 (2015).
- 27. **W. Zhang**, M. Jungfleisch, W. Jiang, J. Sklenar, F. Fradin, J. Pearson, J. Ketterson, and A. Hoffmann, ‘Spin pumping and inverse spin Hall effects - insights for future spin-orbitronics (invited)’, *J. Appl. Phys.* **117**, 172610 (2015).
- 26. **W. Zhang**, M. Jungfleisch, W. Jiang, Y. Liu, J. Pearson, S. G. E. te Velthuis, A. Hoffmann, F. Freimuth, and Y. Mokrousov, ‘Reduced spin-Hall effects from magnetic proximity’, *Phys. Rev. B* **91**, 115316 (2015).
- 25. **W. Zhang**, M. Jungfleisch, W. Jiang, J. Pearson, and A. Hoffmann, ‘Spin pumping and inverse Rashba-Edelstein effect in NiFe/Ag/Bi and NiFe/Ag/Sb’, *J. Appl. Phys.* **117**, 17C727 (2015).
- 24. Z. Li, **W. Zhang**, and K. M. Krishnan, ‘Large-area patterning of sub-100 nm epitaxial L10 FePt dots array via nanoimprint lithography’, *AIP Advances* **5**, 087165 (2015).
- 23. M. B. Jungfleisch, **W. Zhang**, W. Jiang, H. Chang, J. Sklenar, S. M. Wu, J. E. Pearson, A. Bhattacharya, J. B. Ketterson, M. Wu, and A. Hoffmann, ‘Spin waves in micro-structured yttrium iron garnet nanometer-thick films’, *J. Appl. Phys.* **117**, 17D128 (2015).
- 22. W. Jiang, P. Upadhyaya, **W. Zhang**, G. Yu, M. B. Jungfleisch, F. Y. Fradin, J. E. Pearson, Y. Tserkovnyak, K. L. Wang, O. Heinonen, S. G. E. te Velthuis, and A. Hoffmann, ‘Blowing Magnetic Skyrmion Bubbles’, *Science* **349**, 283 (2015).
- 21. S. Das, **W. Zhang**, L. Thoutam, Z. Xiao, A. Hoffmann, M. Demarteau, and A. Roelofs, ‘A Small Signal Amplifier Based on Ionic Liquid Gated Black Phosphorous Field Effect Transistor’, *IEEE Electron Device Lett.* **36**, 621 (2015).
- 20. B. S. Kwon, **W. Zhang**, Z. Li, and K. M. Krishnan, ‘Direct Release of Sombrero Shaped Magnetite Nanoparticles via Nanoimprint Lithography’, *Adv. Mater. Interface* **2**, 1400511 (2015).
- 19. **W. Zhang**, M. Jungfleisch, W. Jiang, J. Pearson, A. Hoffmann, F. Freimuth, and Y. Mokrousov, ‘Spin Hall effects in metallic antiferromagnets’, *Phys. Rev. Lett.* **113**, 196602 (2014).
- 18. **W. Zhang** and K. M. Krishnan, ‘Exchange bias and blocking temperature distribution of Fe-film/CoO-nanoparticle hybrid bilayers’, *J. Appl. Phys.* **115**, 17D714 (2014).

- 17. S. Das, **W. Zhang**, M. Demarteau, A. Hoffmann, M. Dubey, and A. Roelofs, ‘Tunable Transport Gap in Phosphorene’, *Nano Letters* 14, 5733 (2014).
- 16. H. Chang, P. Li, **W. Zhang**, T. Liu, A. Hoffmann, L. Deng, and M. Wu, ‘Nanometer-thick Yttrium Iron Garnet films with extremely low damping’, *IEEE Magn. Letters.* 5, 6700104 (2014).
- 15. B. S. Kwon, Z. Li, **W. Zhang** and K. M. Krishnan, ‘Sombrero-shaped Fe<sub>3</sub>O<sub>4</sub> nanoelements with tunable out-of-plane and in-plane magnetization components fabricated by nano-imprint lithography’, *J. Appl. Phys.* 115, 17B506 (2014).
- 14. **W. Zhang**, V. Vlaminck, J. E. Pearson, R. Divan, S. D. Bader, and A. Hoffmann, ‘Determination of the Pt spin diffusion length by spin-pumping and spin Hall effect’, *Appl. Phys. Lett.* 103, 242414 (2013).
- 13. **W. Zhang** and K. M. Krishnan, ‘Field and temperature-driven magnetic reversal of spin-flop coupled epitaxial Fe/MnPd bilayers’, *Phys. Rev. B* 88, 024428 (2013).
- 12. **W. Zhang** and K. M. Krishnan, ‘Nanoimprint-lithography patterned epitaxial Fe nanowire arrays with misaligned magnetocrystalline and shape anisotropies’, *J. Appl. Phys.* 113, 17B502 (2013).
- 11. **W. Zhang**, T. L. Wen, and K. M. Krishnan, ‘Positive exchange bias and upward magnetic relaxation in a Fe-film/CoO-nanoparticle hybrid system’, *Appl. Phys. Lett.* 101, 132401 (2012).
- 10. **W. Zhang** and K. M. Krishnan, ‘Spin-flop coupling and rearrangement of bulk antiferromagnetic spins in epitaxial exchange-biased Fe/MnPd/Fe/IrMn multilayers’, *Phys. Rev. B* 86, 054415 (2012).
- 9. **W. Zhang** and K. M. Krishnan, ‘Domain wall nucleation in epitaxial exchange biased Fe/IrMn bilayers with highly misaligned anisotropies’, *J. Magn. Magn. Mater.* 324, 3129 (2012).
- 8. **W. Zhang** and K. M. Krishnan, ‘Probing the magnetization reversal in epitaxial Fe/IrMn exchange biased bilayers using angle-dependent anisotropic magnetoresistance’, *J. Appl. Phys.* 111, 07D712 (2012).
- 7. **W. Zhang** and K. M. Krishnan, ‘Direct release of synthetic antiferromagnetic nanoparticles by defect free thermal imprinting’, *J. Appl. Phys.* 111, 07B509 (2012).
- 6. **W. Zhang**, D. N. Weiss, and K. M. Krishnan, ‘Thermal nanoimprint process for high-temperature fabrication of mesoscale epitaxial exchange-biased metallic wire arrays’, *J. Micromech. Microeng.* 21, 045024 (2011).  
Also selected in journal highlight of 2011 and ‘IOP SELECT’.
- 5. **W. Zhang**, M. E. Bowden, and K. M. Krishnan, ‘Competing effect of magnetocrystalline anisotropy and exchange bias in epitaxial Fe/IrMn bilayers’, *Appl. Phys. Lett.* 98, 092503 (2011).
- 4. Q. F. Zhan, **W. Zhang**, and K. M. Krishnan, ‘Antiferromagnetic layer thickness dependence of the magnetization reversal in the epitaxial MnPd/Fe exchange bias system’, *Phys. Rev. B* 83, 094404 (2011).  
Also selected in PRB Kaleidoscope of March 2011

- 3. W. Zhang, D. N. Weiss, and K. M. Krishnan,  
‘Competing anisotropies and temperature dependence of exchange bias in Co/IrMn metallic wire arrays fabricated by nanoimprint lithography’,  
*J. Appl. Phys.* 107, 09D724 (2010).
  - 2. N. Wang, X. Cao, L. He, W. Zhang, L. Guo, C. Chen, R. Wang and S. Yang,  
‘One-pot synthesis of highly crystallized  $\lambda$ -MnO<sub>2</sub> nanodisks assembled from nanoparticles: morphology evolutions and phase transitions’,  
*J. Phys. Chem. C* 112, 365 (2008).
  - 1. J. Huang, L. He, Y. Leng, W. Zhang, X. Li, C. Chen and Y. Liu,  
‘One-pot synthesis and magnetic properties of hollow Fe<sub>70</sub>Co<sub>30</sub> nanospheres’,  
*Nanotechnology* 18, 415603 (2007).

## PRESENTATIONS

Invited

- **Oral presentation (invited):** *Spin Hall effects in metallic antiferromagnets.*  
13th Joint MMM-Intermag Conference, San Diego expected, January 2016
  - **Oral presentation (invited):** *Spin Hall effects and other interfacial spin-orbit effects in magnetic heterostructures.*  
Univ. South Carolina webinar series June 2015

## Contributed

- **Oral presentation:** *Spin Hall effects in CuAu-I-type metallic antiferromagnets.*  
APS March Meeting, San Antonio, TX March 2015
  - **Oral presentation:** *Spin Hall effects in metallic antiferromagnets.*  
59th Annual Conference on Magnetism and Magnetic Materials, Honolulu, HI November 2014
  - **Poster presentation:** *Spin pumping in Permalloy/spacer/Bi or Sb metallic systems.*  
59th Annual Conference on Magnetism and Magnetic Materials, Honolulu, HI November 2014
  - **Oral presentation:** *Determination of the spin diffusion length via spin pumping and inverse spin Hall effect.*  
APS March Meeting, Denver, CO March 2014
  - **Oral presentation:** *Positive exchange bias and upward relaxation in Fe-film/CoO-nanoparticle hybrid bilayers.*  
58th Annual Conference on Magnetism and Magnetic Materials, Denver, CO November 2013
  - **Oral presentation:** *Epitaxial patterning using nanoimprint lithography and magnetization reversal under competing anisotropies.*  
12th Joint MMM-Intermag Conference, Chicago, IL January 2013
  - **Oral presentation:** *Magnetization reversal of epitaxial Fe/IrMn exchange biased bilayers under a domain wall nucleation model.*  
56th Annual Conference on Magnetism and Magnetic Materials, Scottsdale, AZ November 2011
  - **Oral presentation:** *Direct release of synthetic antiferromagnetic nanoparticles by defect free thermal imprinting.*  
56th Annual Conference on Magnetism and Magnetic Materials, Scottsdale, AZ November 2011
  - **Poster presentation:** *Epitaxial exchange biased thin films and nanostructures.*  
IEEE Magnetic Society Summer School, New Orleans, LA May 2011
  - **Poster presentation:** *Mediating the magnetization reversal process via shape anisotropy in large area epitaxial Fe nanowire arrays.*  
55th Annual Conference on Magnetism and Magnetic Materials, Atlanta, GA November 2010

- **Oral presentation:** *Competing anisotropies and temperature dependence of exchange bias in Co/IrMn metallic wire arrays fabricated by nanoimprint lithography.*  
11th Joint MMM-Intermag Conference, Washington D.C. January 2010

## PROFESSIONAL SERVICES

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Referee for the following **14** journals, (#) indicates number of individual papers refereed for this journal:

*Journal of Applied Physics* (5), *Applied Physics Letters* (6), *Physical Review B* (3), *Physical Review Letters* (4), *Physical Review Applied* (2), *Nanotechnology* (1), *Physical Chemistry Chemical Physics* (7), *IEEE Magnetic Letters* (3), *IEEE Transaction on Magnetics* (2), *NPG Asia Materials* (1), *Nature Physics* (1), *RSC Advances* (7), *Journal of Physics D* (4), *Journal of Physical Chemistry* (1)

Total papers refereed: **47**

Referee for Argonne National Laboratory competitive-LDRD research proposals (4)

## REFERENCES

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### **Prof. Kannan M. Krishnan**

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University of Washington – Seattle  
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### **Prof. Mingzhong Wu**

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Colorado State University  
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### **Dr. Samuel D. Bader**

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